JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

November 14, 2006

TO: D. Morris

FROM: A. Andujo

SUBJECT: Cassini Extended Mission Supportability Study

The Resource Allocation Team has completed a special study to analyze the ability of the DSN to provide support for the Cassini Extended Mission.

Background

The Cassini mission is planning the extended phase of the mission. This study is in response to a request to determine the supportability during the 2-year planned extended mission from July 2008 through June 2010. This study focuses on the available capacity of X and Ka band capable DSN antennas throughout the extended mission period.

Summary of Results

This study forecasted Cassini support on each DSN antenna that could support them over the two year extended mission. The results are charted by complex showing the best support any antenna at that complex could provide in any one week throughout the extended mission phase. (See Figure 1) The support from each 34m and 70m antenna at each complex indicate that supportability at the 70 meter subnet is greatly reduced due to the 18 months of consecutive six month downtime blocks for each 70 meter antenna.

Several support scenarios were built with several combinations of DSN 34 and 70 meter assets and separate subnets. However, 34 meter capacity should be able to absorb most 70 meter requirements that oversubscribe the remaining two 70 meter antennas, except in the case of the DSS-43 antenna, where limited assets in Canberra leave fewer options for offloading, thus causing much higher contention at the remaining antennas. The Cassini orbit around Saturn and relatively stable viewperiod should allow enough Northern hemisphere view to support the projected requirements of the mission.

Capacity at the 70 meter antennas throughout the study period is low primarily due to the planned six month downtime of all three antennas consecutively during this period. 70 meter supportability averages at about 68%. (See Figure 2)

Overall contention is due primarily from missions in the Mars and Sun viewperiod. 70 meter Mars mission requirements use most of the available passes. Particularly the M01O THEMIS phase from week 27 of 2009 through week 31 of 2010, increases 70 meter contention dramatically. The SOHO mission also will cause additional contention during their keyhole periods, when 70 meter antenna support is required for approximately two weeks, four times a year.

Assumptions

- DSS – 43 downtime in weeks 40 of 2008 – 13 of 2009
- DSS – 63 downtime in weeks 14 – 39 of 2009
- DSS – 14 downtime in weeks 40 of 2009 – 12 of 2010

Methodology

Analysis was accomplished using the updated mission set database from the August 2006 Resource Allocation Review (RAR).

Analysis was performed by removing currently requested (placeholder) Cassini support and separately loading each DSN 34 and 70 meter antennas with a daily 8 hour pass throughout the extended mission period.

The forecast results are an average supportability of each antenna that could support Cassini per week. The analysis below uses the antenna with the maximum supportability per complex in every week. (See Figure 1)

Saturn 6 degree planetary viewperiods were used for Cassini in this study. Comparison of viewperiod separation with Cassini (Saturn 6 degree) viewperiods with key missions was studied. (See figure 3)

Analysis

The overall supportability of Cassini shows a high correlation that is dependant on the viewperiod separation with Missions in the Mars and Sun view, or rather the requirements of those missions that are in the Mars and Sun view. Viewperiod separation indicates that supportability is lowest when viewperiod separation with Mars and Sun views is lowest and highest when separation percentage is higher. (See figure 4) Right Ascension charts show the clustering of many missions viewperiod with Cassini during low separation and supportability periods.

Supportability is also impacted by the 3 consecutive 6 month 70 meter antenna downtimes. These downtime periods impact the mission in that loading from the down antenna is transferred to either the other 2 antennas in the subnet or to 34 meter antennas within the same complex. During the DSS-43 downtime beginning late 2008 is the period of lowest supportability for Cassini this is primarily due to the limited resources Canberra relative to other DSN complexes.

During minimum solar separation DSN Maintenance alone causes a 14 % reduction in Cassini supportability and is further reduced by mission requirements.

In this period the DSN has 10 – 16 Prime missions and 20 – 26 Extended missions to contend with. (See figure 5)

Canberra supportability is generally lower than supportability at Goldstone and Madrid, due to fewer resources compounded by downtime.

Periods of higher supportability

- 2009 week 01 – 34
- 2009 week 50 – 2010 week 26

Periods of lower supportability

- 2008 week 28 – 52
- 2009 week 35 – 49

Conclusion

Cassini supportability in this period is dependent on the separation of view from the Mars and Sun view, and the support requested by missions in those views (See figures 6 - 8). There are long periods of good supportability and overall the DSN is forecast to be able to provide a daily 8-9 hour pass for Cassini, but the mission may have some difficulty scheduling that time during the periods of low supportability.

Recommendations

It is recommended that the Cassini mission plan more critical events in periods of higher supportability whenever possible. Goldstone and Madrid should be utilized more often than Canberra to provide better overall support.

As always, the results of this study are subject to change, in that network loading changes as requirements for planned missions are input and updated and periods of antenna downtime are identified. We will continue to work with the Cassini mission and other users of the DSN to maximize the time available for each individual user.

Supporting Data

Figure 1: Maximum Cassini Supportability

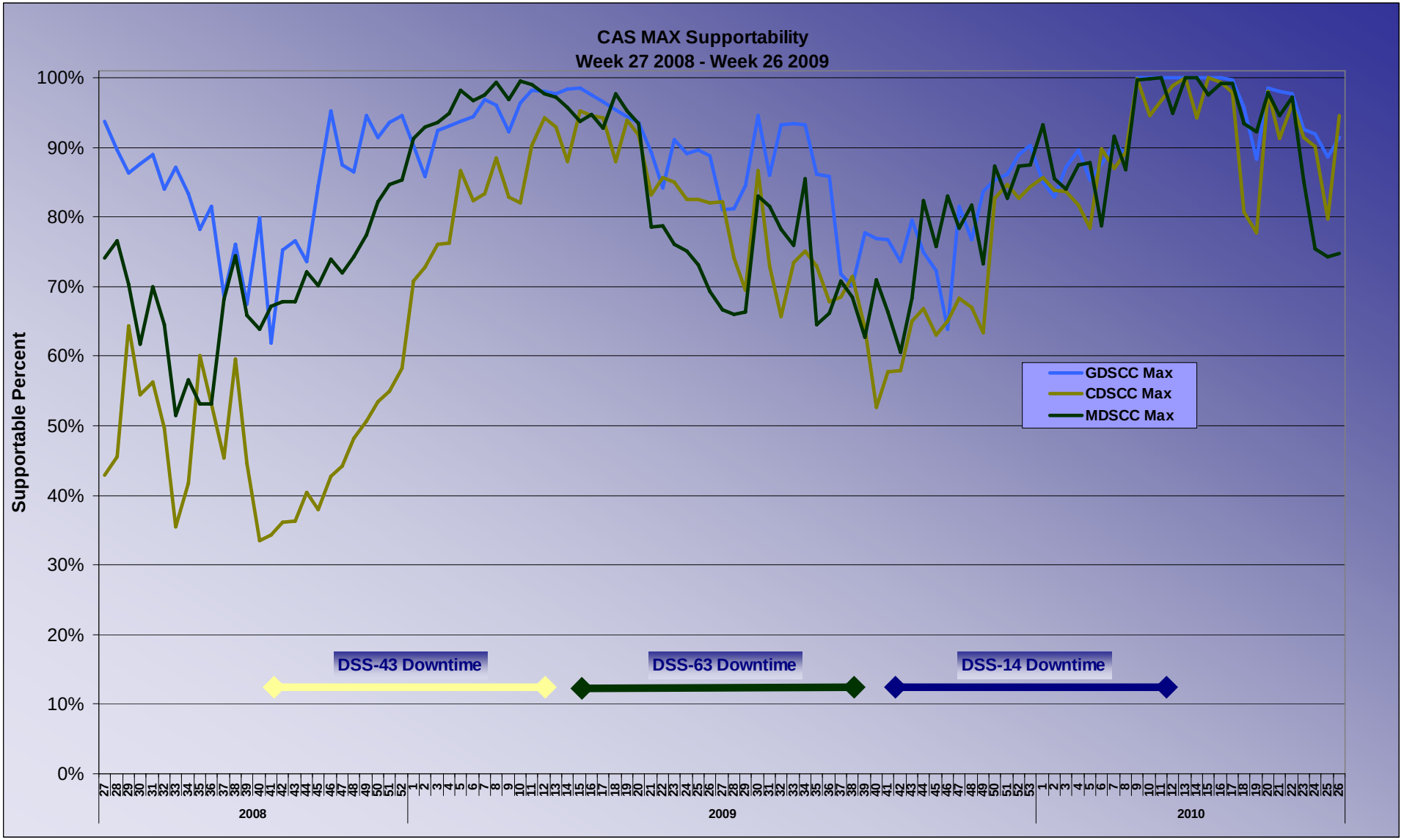

Figure 2: 70 Meter Cassini Supportability

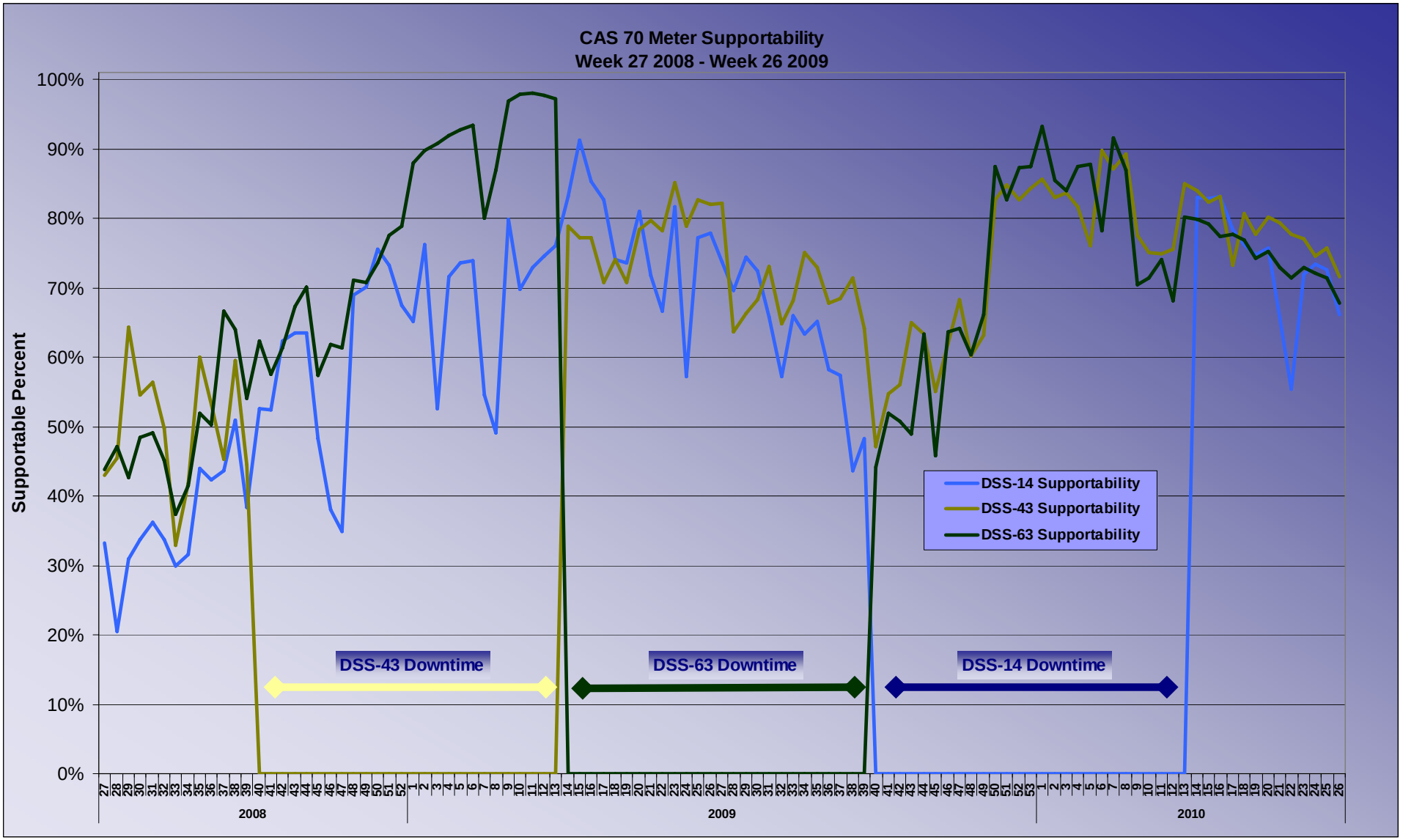

Figure 3: Average Percentage of Viewperiod Separation with Cassini

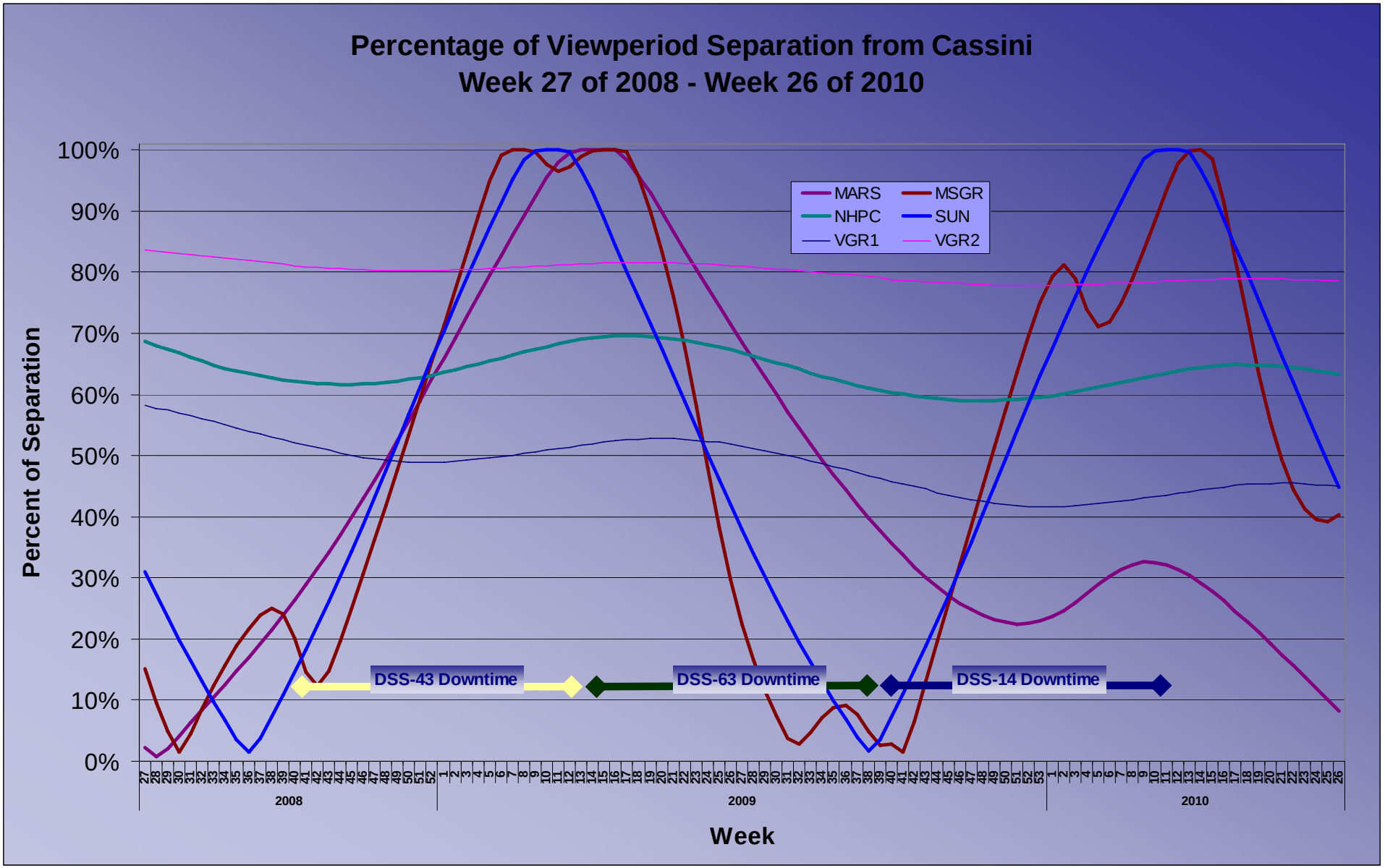

Figure 4: Cassini Supportability Maximums and Viewperiod Separation Overlay

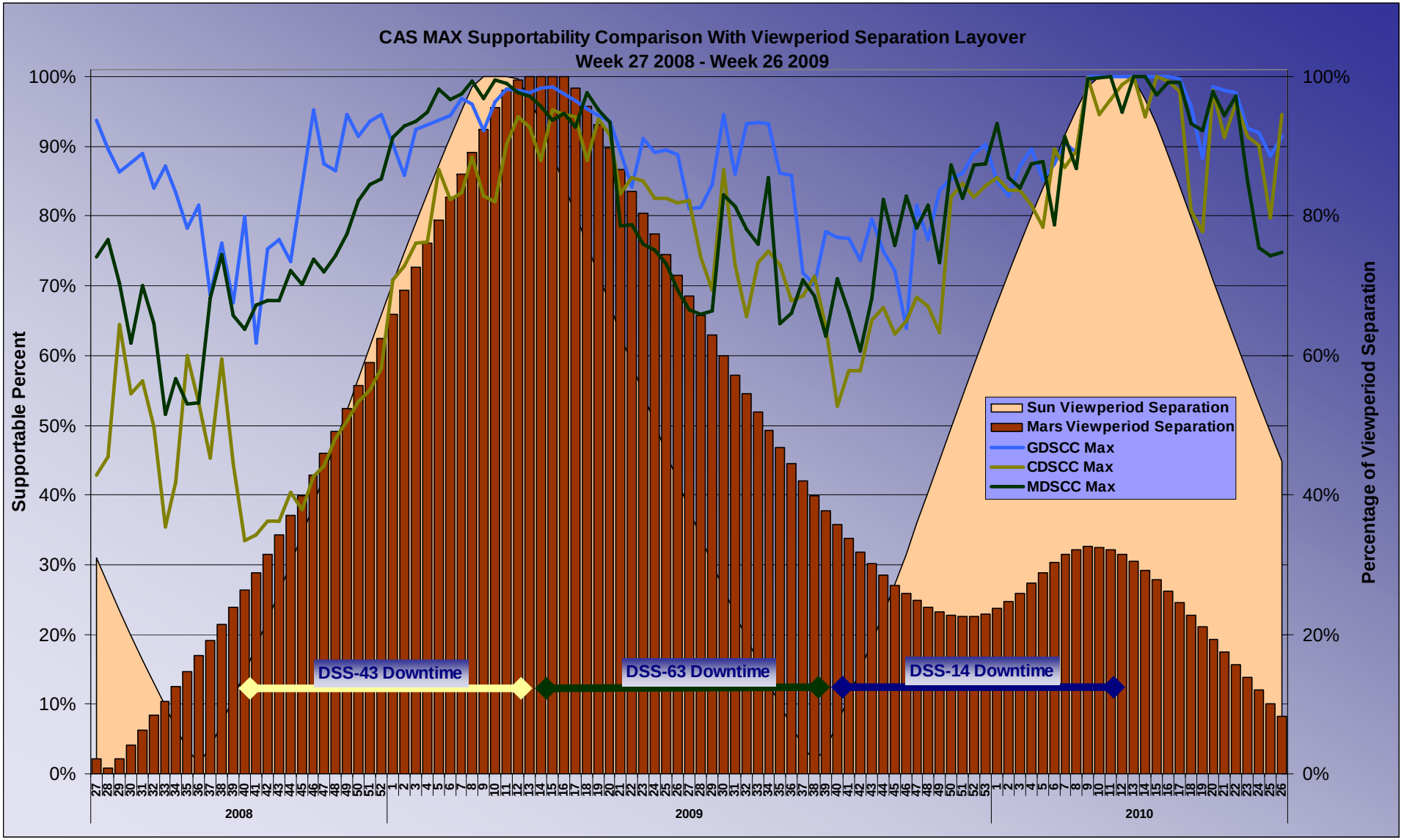

Figure 5: DSN Ongoing and Advanced Mission Set 2008 – 2009

Project	Acronym	Launch or Start	EOPM	EOEM	Advanced or Ongoing	2008	2009	2010
Advanced Composition Explorer	ACE	08/25/97	02/01/01	10/01/13	O			
Advanced Tracking and Observational Techniques (ATOT)	ATOT	02/01/02	12/31/08	- - -	O			
Cassini	CAS	10/15/97	06/30/08	06/30/10	O			
Chandra X-Ray Observatory	CHDR	07/23/99	07/24/09	07/24/14	O			
Chandrayaan - 1	--	03/01/08	03/01/10	TBD	A			
Cluster 2 - S/C #1 (Salsa)	CLU1	08/09/00	02/15/03	12/31/09	O			
Cluster 2 - S/C #2 (Samba)	CLU2	07/16/00	02/15/03	12/31/09	O			
Cluster 2 - S/C #3 (Rumba)	CLU3	07/16/00	02/15/03	12/31/09	O			
Cluster 2 - S/C #4 (Tango)	CLU4	08/09/00	02/15/03	12/31/09	O			
Dawn	DAWN	06/20/07	07/04/15	TBD	O			
DSN Antenna Calibration	DSN	--	--	--	O			
DSN ZDD Calibration	DSN	11/01/04	--	--	O			
DSS Maintenance	DSS	--	--	--	O			
European and Global VLBI Systems	EGS	--	--	--	O			
Geotail	GTL	07/24/92	07/24/95	10/01/08	O			
Goldstone Solar System Radar	GSSR	04/01/85	--	--	O			
Ground Based Radio Astronomy	GBRA	--	--	--	O			
International Gamma Ray Astrophysics Lab	INTG	10/17/02	12/18/04	12/16/10	O			
Juno	JUNO	07/08/10	09/18/16	TBD	A			
Kepler	KEPL	11/01/08	12/01/12	- - -	O			
Lunar Crater Observation and Sensing Satellite (LCROSS)	--	10/31/08	01/31/09	TBD	O			
Lunar Reconnaissance Orbiter	LRO	10/31/08	09/31/10	TBD	O			
Mars Express Orbiter	MEX	06/02/03	02/11/06	12/31/08	O			
Mars Global Surveyor	MGS	11/07/96	02/01/01	11/03/09	O			
Mars Odyssey 2001	M01O	04/07/01	08/24/04	12/31/10	O			
Mars Reconnaissance Orbiter	MRO	08/12/05	12/31/10	12/31/15	O			
Mars Science Laboratory 2009	MSL	10/25/09	03/04/12	TBD	O			
Spirit (Mars Exploration Rover - A)	MER2	06/10/03	04/06/04	09/30/08	O			
Opportunity (Mars Exploration Rover - B)	MER1	07/07/03	04/27/04	09/30/08	O			
Messenger	MSGR	08/03/04	03/19/12	- - -	O			
New Horizons	NHPC	01/17/05	04/17/16	TBD	O			
Phoenix	PHX	08/03/07	10/26/08	TBD	O			
Reference Frame Calibration (Cat M&E and Clock Sync)	DSN	--	--	--	O			
Rosetta	ROSE	02/26/04	12/31/15	- - -	O			
SOHO	SOHO	12/02/95	05/02/98	10/01/11	O			
Space Geodesy	SGP	--	--	--	O			
Spitzer Space Telescope (SIRTF)	STF	08/25/03	05/31/09	05/31/14	O			
Stereo Ahead	STA	09/18/06	09/26/08	09/26/11	O			
Stereo Behind	STB	09/18/06	09/26/08	09/26/11	O			
Ulysses	ULYS	10/06/90	09/11/95	03/30/08	O			
Venus Express	VEX	11/09/05	09/24/07	01/22/09	O			
Voyager 1	VGR1	09/05/77	12/31/80	12/31/10	O			
Voyager 2	VGR2	08/20/77	10/15/89	12/31/10	O			
Wilkinson Microwave Anisotropy Probe	WMAP	06/30/01	10/01/03	09/30/10	O			
Wind	WIND	11/01/94	11/01/97	10/01/11	O			

Prime Mission =
Extended mission =

Figure 6: DSN Mission Right Ascension 2008

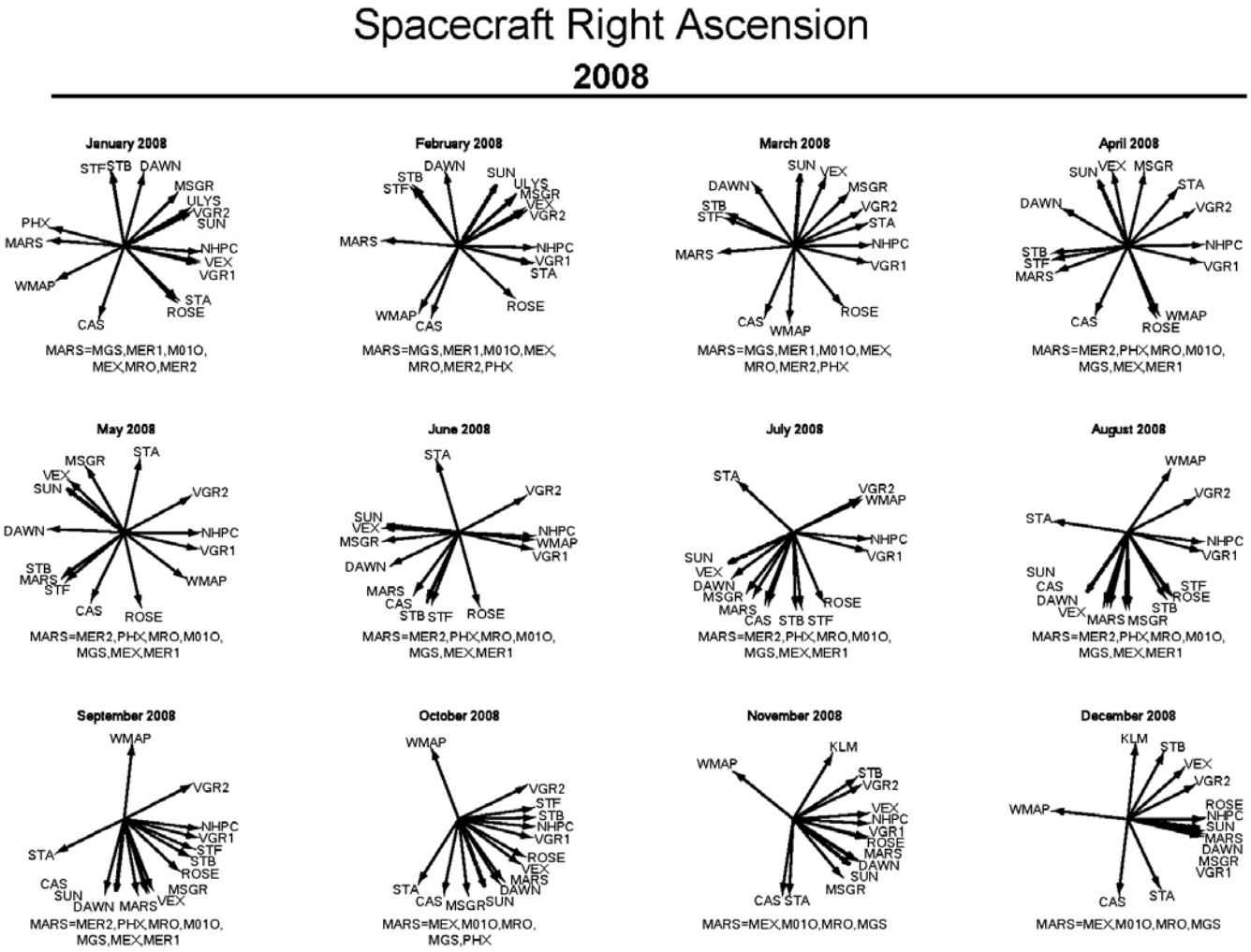

Figure 7: DSN Mission Right Ascension 2009

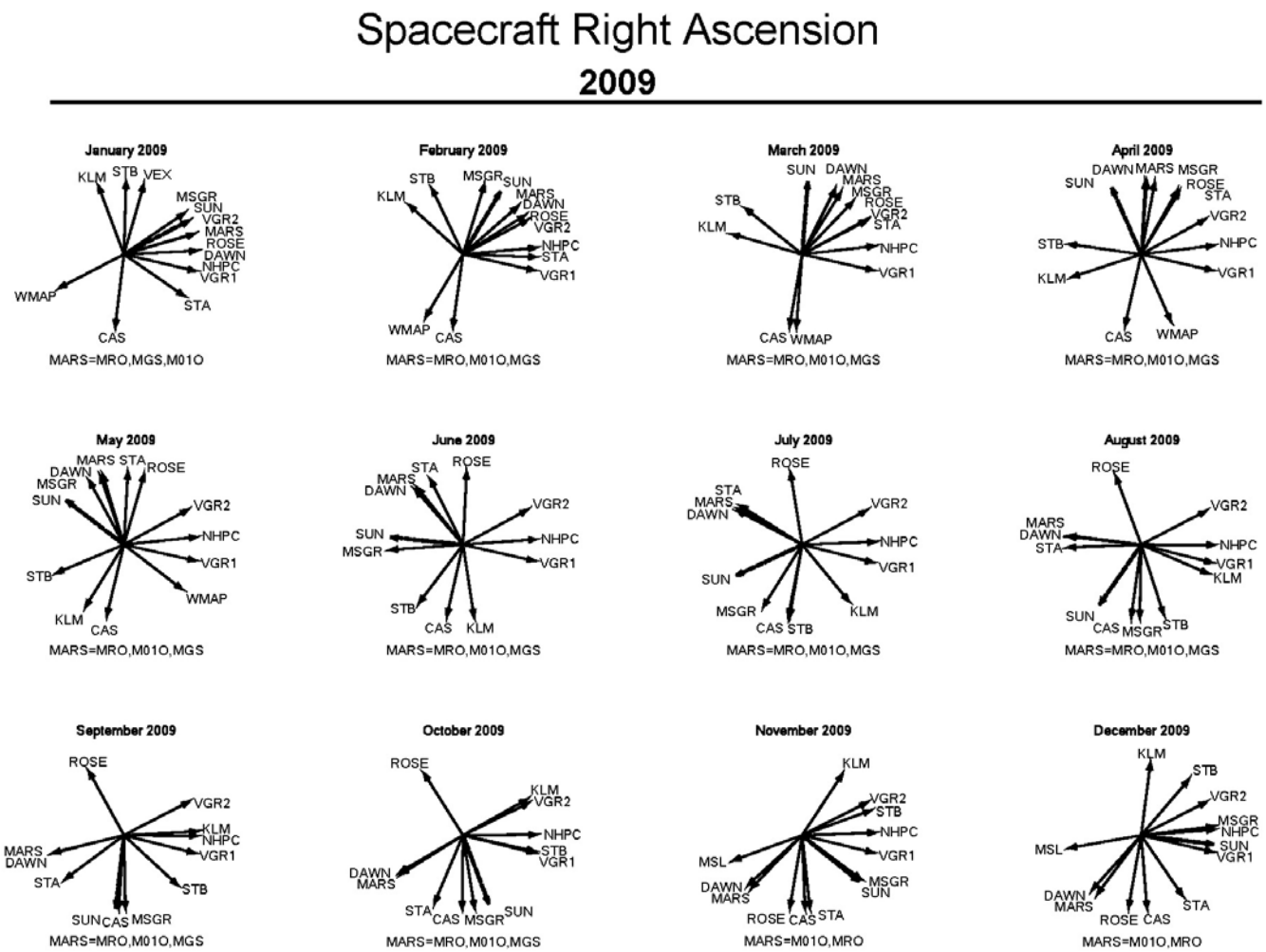

Figure 8: DSN Mission Right Ascension 2010

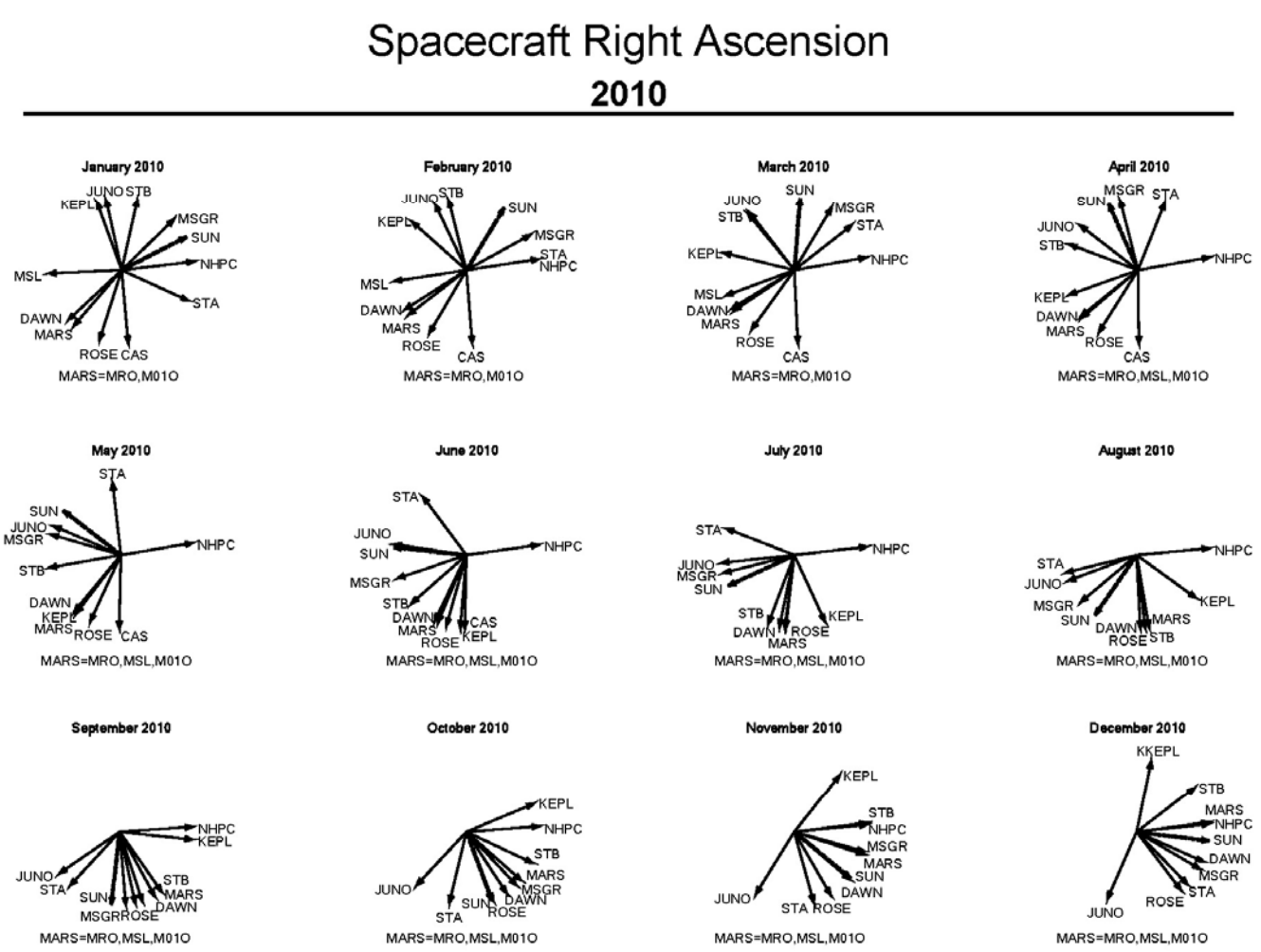

Figure 9: DSN Major Events and downtimes for 2008

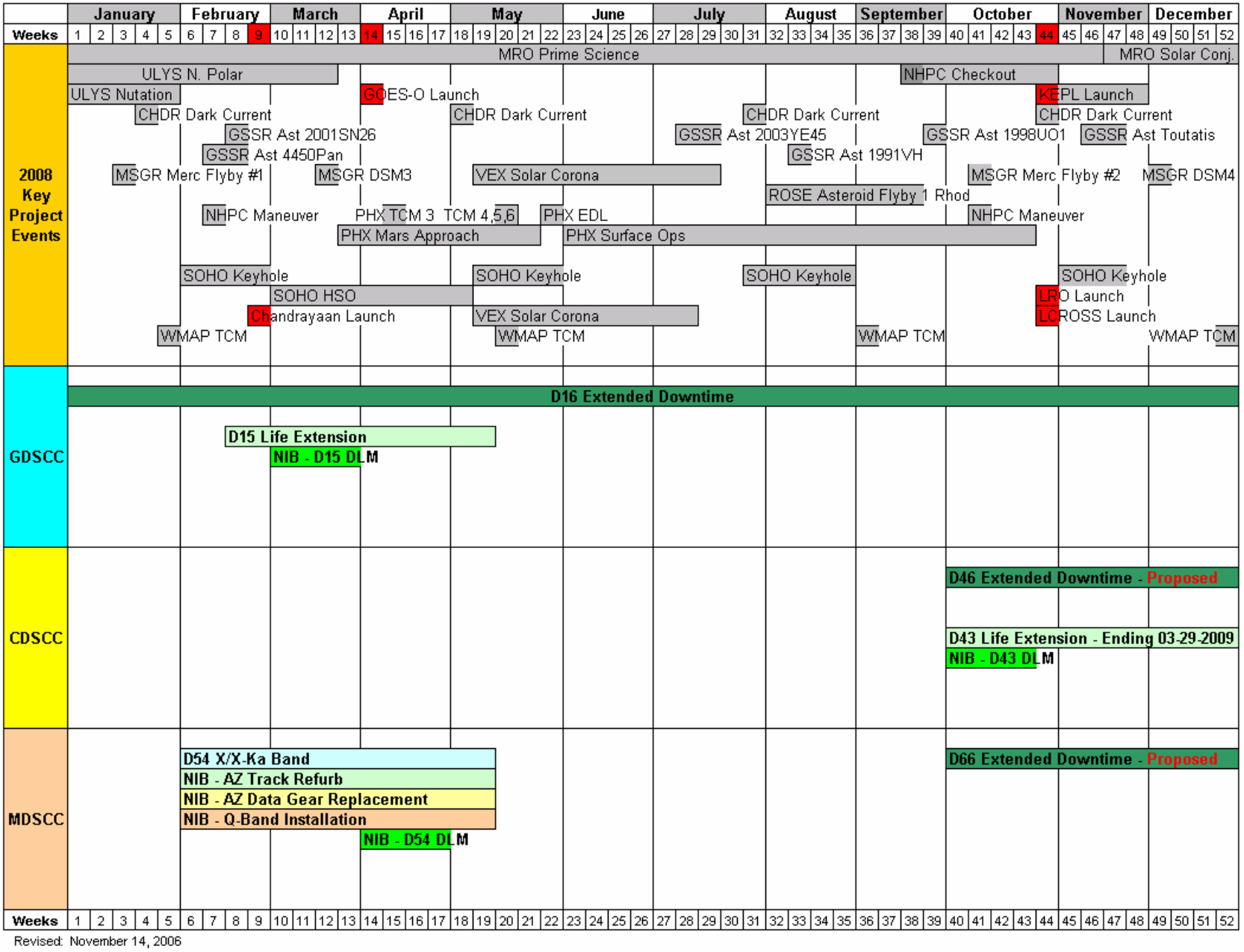

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Figure 10: DSN Major Events and downtimes for 2009

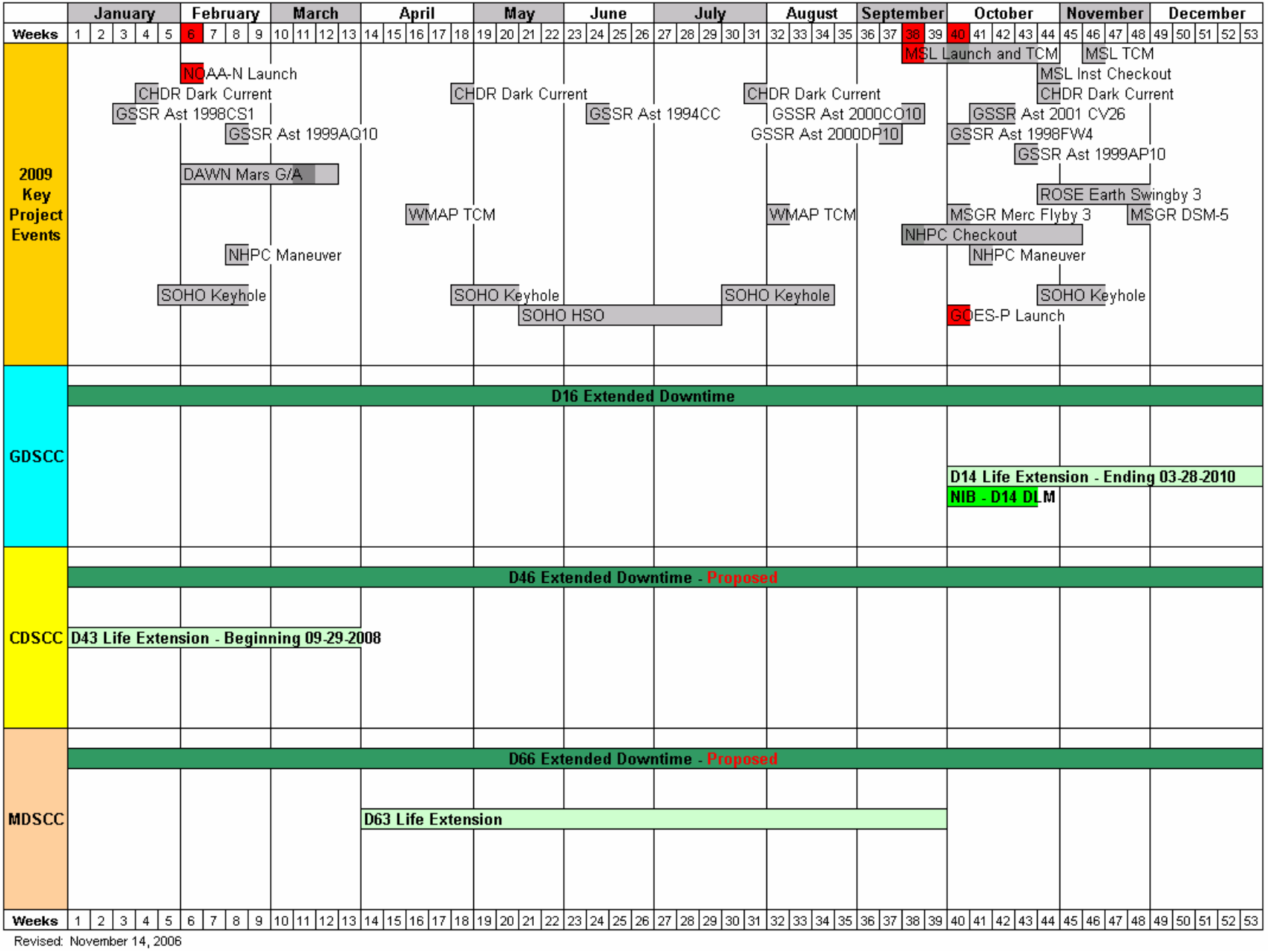

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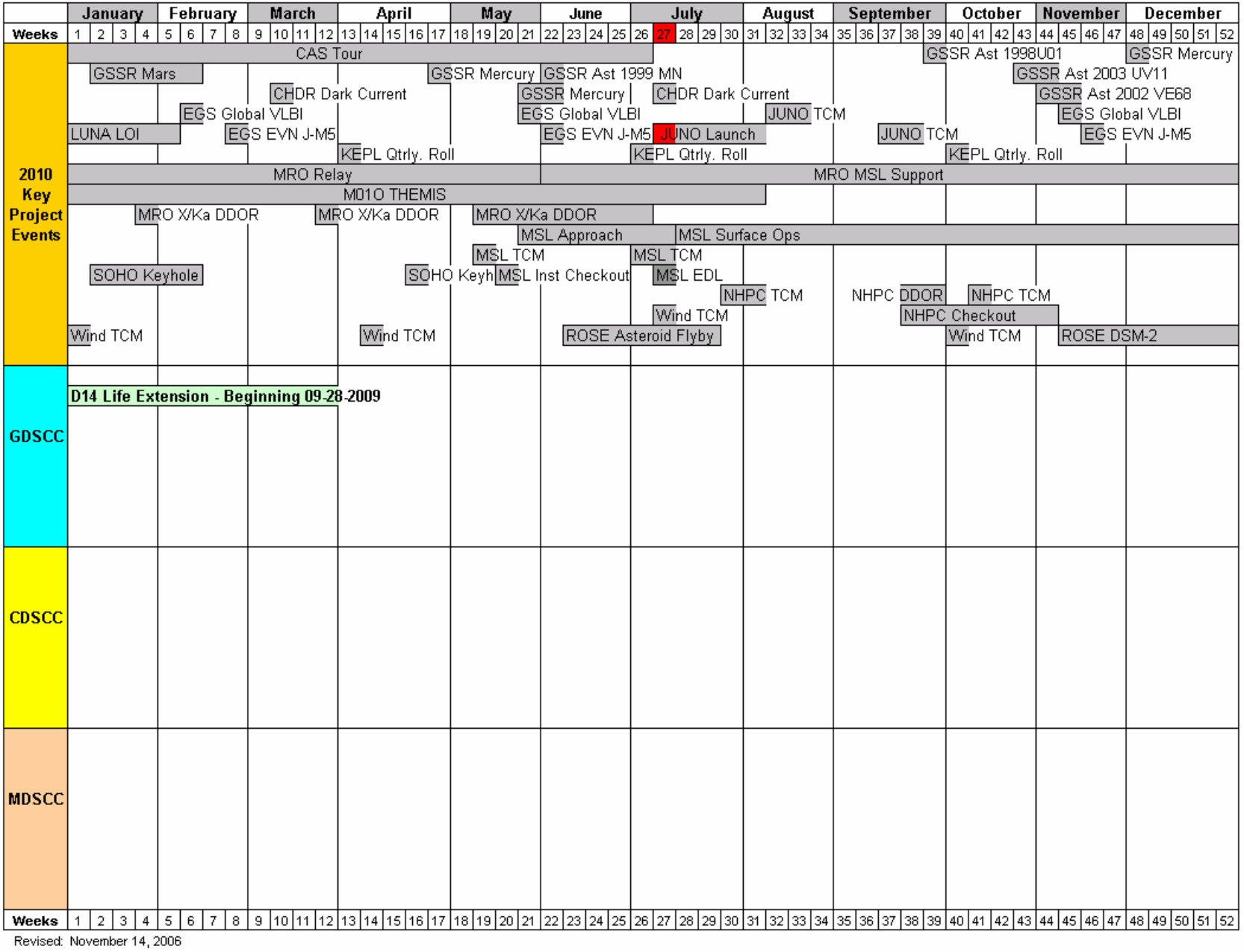
Figure 11: DSN Major Events and downtimes for 2010



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